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ABSTRACT

Presented is a Learning Activity Package (LAP) study concerned with carbon and its compounds. This LAP in chemistry includes a rationale for studying the chemical element of carbon, a list of student objectives (stated in behavioral terms), of activities (reading, laboratory experiments, model construction, etc.), a two-page worksheet, a self-evaluation, and a list of suggested activities for advanced study. (PEB)

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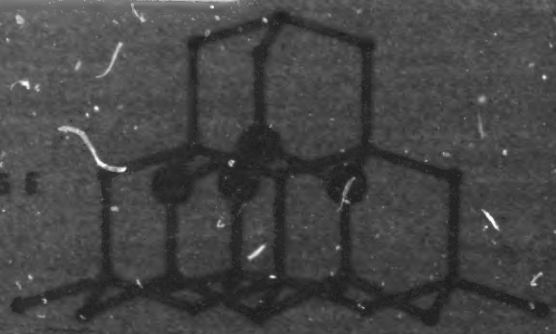
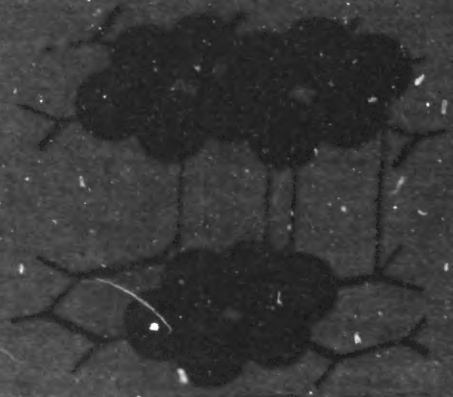
LEARNING ACTIVITY PACKAGE



CARBON

CARBON MONOXIDE

CARBON DIOXIDE



CARBON AND ITS COMPOUNDS

Ninety Six High School · Ninety Six, S.C.

CHEMISTRY I

DEVELOPED BY

J.R.

LAP NUMBER 29

WRITTEN BY Mrs. Jones

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RATIONALE

You have completed your study of acids, bases and salts. In this LAP, you will study the most unique element in Chemistry. This element is carbon. Carbon is found in more compounds than any other element. It is found in all living tissues, in the food we eat and many useful products such as coal, petroleum, natural gas, and limstone. Long - chain carbon compounds play the basic roles in the structure and control of all living things. Due to this knowledge of carbon, man has been able to improve himself and his way of life through the synthesis of medicines, plastics, dyes, and numerous other materials.

CARBON AND ITS COMPOUNDS

BEHAVIORAL OBJECTIVES:

After completing your program of study, you will be able to:

1. Compare the physical and chemical properties of carbon and its compounds.
2. Define allotrophy and show how carbon exists in allotropic forms.
3. List the amorphous forms of carbon and explain how each is formed.
4. Name 5 common methods of preparing carbon dioxide and give the importance of each process.
5. List the physical and chemical properties of carbon dioxide and carbon monoxide.
6. List 5 important uses of carbon dioxide and 3 uses of carbon monoxide.
7. Write the 3 general methods of preparing carbon monoxide and illustrate with equations.
8. Draw a figure to represent the structure of a carbon monoxide molecule which is a resonance hybrid of four structures.
9. Illustrate with equations to show that carbon monoxide will combine with oxygen.

ACTIVITIES:

I. Textbooks

1. College Chemistry (Frey) pp. 475-481

* 2. Concepts In Chemistry (Harcourt) pp. 549-564

3. General Chemistry (Selwood) pp. 425-437

4. Modern Chemistry (Holt, Rinehart, Winston) pp. 268-285

II. Experiments: "Experiments in Chemistry"

1. Carbon # 34 pp. 213-216

2. Carbon Dioxide # 35 pp. 217-219

III. Molecular Model Kit

a. Connect 4 carbon atoms to a 5th carbon atom to make a tetrahedron. Make sure that all the bonds are the same length. Place on the desk, with one side of the base triangle facing you. Construct a second tetrahedron, and set it next to the first. Then remove the carbon atom at the left end of the base of the second tetrahedron and connect the central atom of that tetrahedron to the carbon atom at the right end of the first tetrahedron. Attach a third tetrahedron to the first two in the same manner. (You now have 3 joined tetrahedra, each of which has a single carbon atom above the central carbon atom)

b. Attach 6 carbon atoms to form a regular hexagon; all of the atoms should lie in the same plane, with equal distances between them. A single connector should be used between tow adjacent carbon atoms. Construct another hexagon adjacent to the first and form a honeycomb structure.

TAPE:

Wollensak Teaching Tape

"The Element Carbon" - No. C-7557

SPECIAL ACTIVITIES TO BE COMPLETED BEFORE TAKING THE LAP TEST.

I. Answer on paper - to hand in on page 283. Questions 2, 4, 8, 10,11, 13, 16, 21, 22, 26

II. Answer the Worksheet on Carbon and Its Oxides.

WORKSHEET

Carbon and Its Oxides

PART I Directions: Write on the line at the right of each statement the number preceding the word or expression that best completes the statement.

1. Carbon atoms usually (1) lose 4 electrons; (2) gain 4 electrons; (3) form 4 covalent bonds; (4) share the 2 K-shell electrons. ---------1
2. The weight of carbon dioxide produced by burning a diamond of known weight in pure oxygen indicates that the diamond is composed of (1) pure carbon; (2) pure hydrogen; (3) carbon and hydrogen; (4) carbon and oxygen. ---------2
3. The form of carbon which is a fairly good conductor of electricity is (1) diamond; (2) charcoal; (3) graphite; (4) carbon black. ---------3
4. The internuclear distance between the carbon atoms in the diamond in Angstroms is (1) 1.00; (2) 1.54; (3) 3.40; (4) 1.42. ---------4
5. The destructive distillation of wood produces (1) coke; (2) charcoal; (3) boneblack; (4) lampblack. ---------5
6. The bonding electrons of carbon atoms are the (1) two 2*s* electrons and the two 2*p* electrons; (2) one 2*s* and three 2*p* electrons; (3) four 2*p* electrons; (4) three 2*s* and one 2*p* electrons. ---------6
7. Heating bituminous coal in the absence of air in closed retorts yields the volatile product (1) wood alcohol; (2) coke; (3) acetic acid; (4) ammonia. ---------7
8. Crude sugar solutions are decolorized by filtration through (1) graphite; (2) boneblack; (3) lampblack; (4) coke. ---------8
9. Burning natural gas in an insufficient supply of air is used to produce (1) charcoal; (2) coke; (3) carbon black; (4) graphite. ---------9
10. The most commonly used reducing agent in metallurgy is (1) coke; (2) graphite; (3) bone black; (4) charcoal. ---------10
11. The fermentation of molasses produces (1) ethanol and carbon dioxide; (2) methanol and acetic acid; (3) tar and ammonia; (4) ethanol and carbon monoxide. ---------11
12. Carbon monoxide is produced from carbon dioxide by (1) cracking; (2) reduction with carbon; (3) destructive distillation; (4) reaction with formic acid. ---------12
13. A poisonous gas which combines permanently with the hemoglobin of the blood is (1) CO_2; (2) CH_4; (3) CO; (4) C_2H_2. ---------13
14. Dry ice is solid (1) CO; (2) CH_4; (3) CO_3; (4) CO_2. ---------14
15. The anhydride of carbonic acid is (1) CO; (2) CO_2; (3) CO_3; (4) HCO_3^-. ---------15
16. The precipitate formed when carbon dioxide is bubbled into limewater is (1) $CaCl_2$; (2) H_2CO_3; (3) CaO; (4) $CaCO_3$. ---------16
17. The principal fire-extinguishing agent in the soda-acid type of fire extinguisher is (1) carbon dioxide; (2) water; (3) bicarbonate of soda; (4) licorice. ---------17
18. A burning metal which continues to burn in carbon dioxide is (1) Zn; (2) Mg; (3) Al; (4) Fe. ---------18
19. In one layer of a graphite crystal, each carbon atom is bonded to (1) one; (2) two; (3) three; (4) four; other carbon atoms. ---------19
20. Synthetic methanol is made from (1) yeast and molasses; (2) carbon dioxide and water; (3) carbon monoxide and hydrogen; (4) methane and carbonic acid. ---------20
21. The densest form of carbon is (1) diamond; (2) graphite; (3) charcoal; (4) coke. ---------21
22. A substance produced by an endothermic reaction in an arc-type electric furnace is (1) graphite; (2) carbon disulfide; (3) coke; (4) charcoal. ---------22
23. The nature of the bonding in substances when combination of two or more valence bond is required is designated as (1) refractory; (2) allotropism; (3) resonance; (4) activation. ---------23
24. The layers in graphite are held together by (1) ionic forces; (2) nonpolar covalent forces; (3) polar covalent forces; (4) van der Waals forces. ---------24
25. Crucibles used for melting steel are made from (1) coke; (2) graphite; (3) charcoal; (4) boneblack. ---------25
26. Charcoal may be activated by treating it in retorts with (1) carbon dioxide; (2) steam; (3) sand; (4) ammonia. ---------26
27. Coal tar can be separated into many materials by (1) cracking; (2) distillation; (3) adsorption; (4) absorption. ---------27

28. The impurity in boneblack can be removed by treating it with (1) calcium phosphate; (2) an acid; (3) steam; (4) alcohol. ---------28

29. The form of carbon which makes tires wear better is (1) boneblack; (2) graphite; (3) carbon black; (4) activated charcoal. ---------29

30. The hybrid orbitals of the carbon atom in methane are called (1) sp orbitals; (2) sp^2 orbitals; (3) sp^3 orbitals; (4) sp^4 orbitals. ---------30

31. The existence of an element in two or more forms in the same physical state is (1) resonance; (2) allotropy; (3) amorphous; (4) hybridization. ---------31

32. The layers of graphite have a structure in which the carbon-carbon bonds are (1) only single bonds; (2) only double bonds; (3) both single and double bonds; (4) intermediate in character between single and double bonds. ---------32

33. When calcium carbonate is heated strongly the gas produced is (1) O_2; (2) CO_2; (3) CO; (4) CaO. ---------33

34. Carbon dioxide may be collected (1) only by air displacement upward; (2) only by water displacement; (3) only by air displacement downward; (4) either by air displacement upward or by water displacement. ---------34

35. Of the following gases, the one which diffuses least rapidly is (1) O_2; (2) N_2; (3) CO; (4) CO_2. ---------35

36. Carbon monoxide is produced from formic acid by reaction of the acid with (1) hot carbon; (2) hot, concentrated sulfuric acid; (3) hot carbon dioxide; (4) a catalyst of zinc oxide and copper. ---------36

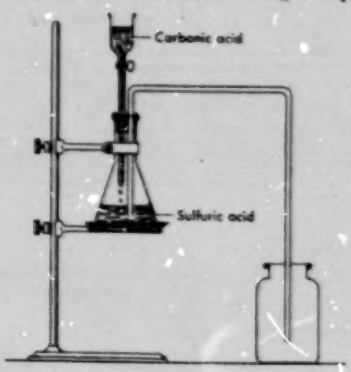
37. Carbon dioxide molecules are believed to be resonance hybrids of how many electronic structures? (1) 1; (2) 2; (3) 3; (4) 4. ---------37

38. The final products of photosynthesis are (1) CO_2 and H_2O; (2) $C_6H_{12}O_6$ and O_2; (3) C_2H_5OH and CO_2; (4) O_2 and CO_2. ---------38

39. In the foam type of fire extinguisher, the carbon dioxide is liberated from the (1) calcium carbonate; (2) sodium hydrogen carbonate; (3) alum; (4) licorice. ---------39

40. Passing steam over hot coke produces the compound of carbon (1) CH_4; (2) CO_2; (3) CO; (4) H_2CO_3. ---------40

PART II Directions: Using a separate sheet of paper, write the answers to the following questions.



41. Using complete sentences, state 4 corrections that would have to be made in the apparatus at the left so that carbon monoxide could be prepared and collected.

42. For the diamond, briefly explain its (a) hardness; (b) density; and (c) melting point.

43. In terms of hybridization, briefly explain why the observed bond angle in water is 105°.

44. (a) Draw the electron-dot structures for the 4 resonance hybrids of carbon monoxide. (b) Briefly explain the slight polarity of the CO molecule.

SELF EVALUATION:

(1) I. Select the correct letter.

1. Coke is produced by the destructive distillation of:

   (a) peat (b) lignite (c) bituminous coal (d) anthracite coal _____

2. Each of the following is a by-product of the formation of coke except:

   (a) coal tar (b) coal gas (c) ammonia (d) acetylene _____

3. Each of the following is a by-product of the manufacture of coke except:

   (a) ammonia gas (b) coal gas (c) coal tar (d) bituminous coal _____

4. Because of the weak bonding between the carbon atoms in its different planes, graphite is both a good conductor and a good:

   (a) lubricant (b) fuel (c) oxidizing agent (d) abrasive _____

5. Carbon monoxide unlike carbon dioxide is:

   (a) an acid anhydride (b) a reducing agent (c) detected when inhaled (d) found in exhaust gases of cars. _____

6. Among the following, the saturated hydrocarbons are the

   (a) alkanes (b) alkadienes (c) alkenes (d) alkynes _____

7. Natural gas is composed of about 90 percent:

   (a) ethene (b) benzene (c) methane (d) ammonia _____

8. Carbon atoms usually:

   (a) lose four electrons (b) gain four electrons (c) form four covalent bonds (d) share the two K-shell electrons _____

9. The form of carbon which is a fair conductor of electricity is:

   (a) diamond (b) graphite (c) charcoal (d) carbon black _____

10. The bonding electrons of carbon atoms are the:

    (a) two 2 s electrons and the two 2 p electrons
    (b) one 2 s and three 2 p electrons
    (c) four 2 p electrons
    (d) three 2 s and one 2 p electrons _____

(2) II. A. Name the 2 solid allotropic forms of carbon.

1. _____

2. _____

Self Evaluation (cont.)

B. Name 3 other elements beside carbon that are allotropic.

1. _____

2. _____

3. _____

C. Give the 2 causes of allotropy.

1. _____

2. _____

(3) III. A. What kind of bond holds carbon atoms? _____

B. How are the carbon atoms held together in graphite?

_____

C. Charcoal is prepared by the destructive distillation of

_____

D. Which form of carbon is produced by heating bituminous coal?

_____

E. How is boneblack produced?

_____

F. How is carbon black produced?

_____

(4) IV. A. Name the two products formed by heating calcium carbonate.

1. _____

2. _____

B. What is the natural way of preparing carbon dioxide?

_____

C. What is the industrial method of producing alcohol and carbon dioxide?

_____

D. What is the cheapest and easiest way of preparing carbon dioxide?

_____

(cont.)

Self Evaluation (cont.)

(5) V. Complete:

	Carbon Dioxide	Carbon monoxide
taste	1.	1.
color	2.	2.
odor	3.	3.
formula	4.	4.
solubility	5.	5.

(6) VI. Name 5 uses of carbon dioxide.

1. _____
2. _____
3. _____
4. _____
5. _____

(7) VII. 1. What is used to reduce carbon dioxide to form carbon monoxide?

_____

2. Write the formula for the industrial method of preparing coke.

_____

3. What is the laboratory method of preparing carbon monoxide?

_____

(8) VIII. Draw 4 figures to represent the resonant hybrid of carbon monoxide.

(9) IX. 1. Write the equation of the union of carbon monoxide and oxygen when heat is applied. (Balance the equation.)

(cont.)

Self Evaluation (cont.)

2. Write an equation that shows carbon monoxide reacting with another material that will illustrate reduction.
(Balance the equation.)

ADVANCED STUDY

I. A. Carbon dioxide is a product of the combustion of carbon, yet magnesium will burn in carbon dioxide. Explain how this is possible.

B. Gasoline is a mixture of carbon and hydrogen, which can be approximately representend by C_7H_{16}. Indicate by a balanced equation how carbon monoxide, carbon dioxide and water could be formed by combustion of gasoline in an automobile engine.

C. Contrast and discuss the physical properties of the allotropes of carbon in terms of their structures.

II. Draw Lewis structures for

a. Malonic acid
b. Carbon suboxide
c. Carbon dioxide
d. Germaine
e. Silicon Carbide

III. A. Write complete balanced equations (empirical) for the following chemcial reactions.

1. Complete combustion of carbon monoxide
2. Fermentation of sugar $C_6H_{12}O_6$
3. Calcium carbonate and hydrochloric acid

B. Write net ionic equations for the following reactions

1. The reaction in a soda-acid fire extinguisher
2. The reaction between aqueous sodium hydroxide and carbon dioxide.
3. For the following reaction starting with 80 grams of iron (III) oxide, calculate (a) the number of moles of carbon monoxide required (b) the number of grams of iron produced (c) the volume of carbon dioxide produced at S. T. P.

$$Fe_2O_3 + 3\ CO \longrightarrow 2Fe + 3\uparrow CO_2$$

IV. A. Determine how many milligrams of a 100 milligram sample of radium will disintegrate in 30 days.

B. Cypress wood from the ancient Egyptian tomb of Sneferu at Meydum had an activity of 6.88 cpm/g of carbon. Estimate the age of this wood (and presumably the age of the tomb)